Notes

The Epizootic and Epidemic Situation in the Natural Foci of Plague in the USSR and the Prophylactic Measures Taken *

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In the USSR there are, as is well known, active natural plague foci in Kazakhstan, Central Asia, the Lower Volga Region, Transcaucasia and Transbaikalia.

The fruitful teachings of Academician E. N. Pavlovski concerning diseases which occur in natural foci, based in respect of plague on the investigations of pre-revolutionary and Soviet scientists—D. K. Zabolotny, I. A. Deminski, N. N. Klodnitski, G. I. Koltsov, N. F. Gamaleya, S. M. Nikanorov, N. A. Gaiski, D. A. Golov, I. G. Ioff, M. M. Tikhomirova, B. N. Pastukhov, I. M. Rall, V. N. Fedorov, I. S. Tinker, N. I. Kalabukhov, P. N. Stupnitski, B. K. Fenyuk and many others—made it possible to establish the existence of the following natural foci of plague in the USSR: (1) the Caspian Region, (2) the Central Asian Region, divided into plain and mountain areas, (3) the Transcaucasian Region, and (4) the Transbaikalian Region.

In the process of studying plague foci about forty species of rodents and a still larger number of flea species which maintain the plague foci were discovered. Of course, not all these rodents and fleas are of equal importance in this respect.[a]

The constant (basic) carriers of plague in the conditions ruling in the USSR are the long-tailed and Mongolian marmots, the little sisel (suslik) and the midday and great gerbils. Facultative carriers may be the large-toothed sisel, the hairy-legged and small jerboas and the red-tailed and tamarisk gerbils. Important temporary carriers are the common mouse and the social vole. All other carriers play only a chance part in plague epizootics.

The most important vectors of plague in the conditions of the individual foci have proved to be the fleas of the basic rodent carriers: *Xenopsylla hirtipes*, *X. gerbilli minax* I., *X.g. caspica* J., *X. skrjabini* J., *X. conformis* W., *Ceratophyllus tesquorum* W., *Neopsylla setosa* W., *Oropsylla silantiewi*.

In the USSR are found about one-fifth of the list of the world's plague vectors and about the same proportion of all species of rodents (140 species).

The *Caspian plague focus* [b] in the past covered the Caspian Depression. The north-west boundary in the main follows the Ergensk Heights and the Manych semi-desert—including the lowland regions of the north (Grozny) and east (to the south of the mouth of the Sulak)—to the eastern fringe of the Caucasus and on the northern side to the right bank of the Volga. The focus extended to the bend of the Volga in the Stalingrad region and in the district between the Volga and Ural rivers as far as the mouth of the river Kushum. To the east the focus extended beyond the Ural river and covered the Dzhambeitinsk, Karatyubinsk and Taipaksk regions of West Kazakhstan province and the Kizyl-Kuginsk region of Guryev province, having a common boundary in the southern part of the Trans-Ural area with the Central Asian focus; the boundaries between the two foci are not clear.

In the steppe region of the focus the main carrier and reservoir of plague infection was the population of little sisels (*Citellus pygmaeus* Pall.), from which people could be infected in the summertime as a result of contact. In the sandy parts of the focus, the main carriers of plague infection are the midday gerbil (*Meriones meridianus* Pall.) and possibly the tamarisk gerbil (*Meriones tamariscinus* Pall.).

In the autumn and winter, house mice and small field mice, infected with the plague by sisels and gerbils in the summer, may take part in the transmission of plague to human beings.

The *Central Asian focus* is the biggest in the Soviet Union. It stretches from the eastern shores of the Caspian Sea on the west to the crests of the eastern

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[a] Lists of rodents and fleas incriminated in the spread of plague in various parts of the world, including the USSR, are appended to the article by R. Pollitzer on page 313 of this issue.

[b] See the article by B. K. Fenyuk on page 263.

Tian Shan and Tarbagatai on the east. Its northern boundary passes roughly along the Emba Plain, the northern shores of the Aral Sea and the southern part of the Kazakh volcanic region. The southern boundary runs outside the Soviet Union into Iran, Afghanistan and China. In the south-west the focus connects with the Iran/Asia-Minor and Transcaucasian foci and in the north-west with the Caspian focus.

The work carried out in Central Asia in the last few years gives a fairly complete and concrete picture of the plague focus. The main reservoirs and carriers of plague infection in the lowland (desert) part of it are the great gerbils (*Rhombomys opimus* Licht.), which together with other rodents may act as a source of plague infection in man. An essential role in the spread of the causative agent of plague in this focus is played by the red-tailed gerbils (*Meriones erythrourus* Gray). In the high mountain area of the Central Asian focus the reservoirs of plague are the Altai marmot (*Marmota baibacina* Kastsch.) and the long-tailed marmot (*Marmota caudata* Geoffr.).

The *Transcaucasian focus* is bounded on the north by the great Caucasian range, while its southern border is outside the Soviet Union in Turkey and Iran. To the west the focus extends as far as the middle course of the Kura river near the city of Rustavi and to the east it stretches to the Caspian Sea.

In this focus the main role in the maintenance of enzootic plague is played by the gerbils, including possibly the red-tailed gerbils.

The *Transbaikalian focus* is part of the extensive Central Asian focus. In the south it borders on the plague-enzootic areas of the Mongolian People's Republic. Its western boundary passes along the Argun River; its limits in the north coincide with the desert steppe zone; to the east it stretches as far as the Borun-Torei Lake. The main carriers and reservoirs of plague in this focus are the Siberian marmots (*Marmota sibirica* Radde).

Camels have also been a considerable factor in the spread of plague.[c] They are infected apparently by rodent fleas since cases of plague in camels have been observed only in places where there are intensive epizootics among rodents. The infection of people by plague-sick camels can take place when the camels are slaughtered and skinned and their flesh cut up.

[c] See the article by V. N. Fedorov on page 275.

There are no permanent rat foci of plague in the USSR. Short-lived plague epizootics among rats which have been observed in the USSR and which caused infection among people (in Odessa in 1901, 1902 and 1910, and in Batum in 1901, 1916 and 1921) were the result of the importation of plague into these ports from abroad.

An especially important role in the entrenchment of plague and its spread and transmission to human beings is played, as is well known, by ectoparasites of rodents, chiefly fleas. The intensive investigations of this problem as it applies to the USSR, carried out by Soviet parasitologists under the leadership of Professor I. G. Ioff, must be mentioned here. The mass of fundamental research into the importance of various species of fleas in the natural plague foci carried out by Professor Ioff have made it possible to elaborate a number of new ideas and prophylactic measures which have won wide recognition.

In the past, at the end of the nineteenth century and during the first twenty-five years of the twentieth century, plague epidemics among the local population, which in some years cost tens or hundreds of human lives, were observed in the zones of natural plague foci; since about 1928, however, when plague control measures began to be developed on a large scale, there have been no cases of plague in human beings in the USSR. Plague epizootics among rodents, however, still take place in a number of localities in the zones of natural plague foci. In some years epizootics have covered a considerable area and have run their course in an acute and generalized form.

The considerable size of the area in the USSR where plague is enzootic is not in itself any reason for pessimism, for no cases of plague occur. The reason for this is in the first place the carefully organized plague intelligence system, constant control and wide prophylaxis. Rodent and flea control on a huge scale is consolidating the results achieved by these measures. Such foci as the Transbaikalian and western Caspian areas are now on the list of former plague areas from which the disease has died out.

All measures connected with plague prevention and control in the USSR are carried out by a network of anti-plague institutes of the USSR Ministry of Health. The organizational structure and distribution of these establishments is based on the situation with regard to plague epidemics and epizootics in the USSR and neighbouring countries. Long

experience in the organization of anti-plague services in a single centralized system has shown all the advantages of such an arrangement. Centralization has enabled complete and timely fulfilment of the basic task of the system—to ensure that there are no plague epidemics in the country. The existing structure of the system has enabled all plague prevention and control measures to be carried out without regard to administrative boundaries of republics, regions and provinces by means of the combined efforts and equipment of the whole system.

In ensuring the freedom of the USSR from plague epidemics an important role has been played by the extensive, systematic and timely carrying out of a whole interconnected series of prophylactic measures.

New tactics worked out by the epidemic intelligence service have enabled more extensive territories to be investigated than in the previous period. Almost all the areas where plague is active or threatening have been covered by epidemiological investigations, i.e., the systematic observation of the condition and numbers of rodents and their fleas and their examination for plague infection.

Every year more than 40 million hectares of land are covered by such investigations, in addition to a number of ports and large centres of population. Every year, too, more than one million rodents and about five million ectoparasites are subjected to bacteriological examination. In this most important work a new method of epizootiological investigation has been used on a wide scale which not only enables large areas to be covered but allows the epizootic conditions in them to be determined within a very short space of time. This has been achieved by differences in approach to the investigation of each particular territory based on the tasks facing the investigators. In some cases wide use has been made mainly of examination of the ectoparasites, in others of a combined examination of rodents and ectoparasites.

Investigations carried out during these years have made it possible to detect at one and the same time several special features of the epizootic process and its course; this has made easier the correct planning and carrying out of plague prevention measures.

In carrying out prophylactic measures the anti-plague services have paid serious attention to keeping a systematic watch on the state of health of the population in regions where plague is enzootic. This has been done not only by the staff of the anti-plague stations but by medical workers in general, who have been drawn into the work, and without whom it would have been quite impossible to carry out medical examinations on a full scale.

In accordance with the emphasis on prevention which marks the Soviet health system, rodent control in the areas of natural plague foci is looked upon as one of the most fundamental anti-plague measures. The destruction of rodents where there are natural plague foci is carried out as a planned State measure. Every year up to seven million hectares of land are covered by the campaign to eradicate various species of rodents which act as reservoirs or carriers of plague.

The introduction of new methods of rodent control, in particular the use of poison baits, the extension of the range of poisons used (zinc phosphide, black cyanide, barium fluoracetate, etc.) and the wide use of aircraft in this work is worthy of note.

Rodent eradication in the area of natural plague foci has been carried out with various ends in view. In the Caspian focus, particularly on the right bank of the Volga, the eradication work has been carried out with the intention of eradicating the natural foci of plague. In the south of the Volga-Ural sandy areas, in western Kazakhstan and in Chita province, the aim has been to forestall the development of epizootics. In the other places, particularly in the Central Asian and Transcaucasian foci, work has been carried out with the aim of suppressing intensive plague epizootics and of forming so-called "protective zones" to lessen the possibility of human beings becoming infected with plague.

The systematic eradication of rodents has helped to decrease their numbers, although in the case of some rodent species (e.g., the gerbils) the decrease has been short-lived and unstable, and in that way has led to a decrease in the degree of infection in the foci. There is no doubt that only as a result of rodent extermination work has it been possible to achieve a radical change for the better in health conditions in the north-west part of the Caspian focus and the complete eradication of enzootic plague in a very considerable proportion of that territory. In the southern zone of the Volga-Ural sands, repeated destruction of gerbils over large areas during the last few years has had satisfactory epidemiological results. In the Transbaikalian focus the work carried out has sharply decreased the numbers of marmots and has made conditions radically healthier.

Special attention must be drawn to wide experience in the simultaneous extermination of red-tailed gerbils and their fleas by using black cyanide mixed with hexachlorocyclohexane. As a result of this work an epizootic was quickly suppressed and the effect has been relatively stable.

Side by side with the work of rodent extermination in the field the anti-plague services have carried out large-scale, systematic work on deratization, insect disinfestation and disinfection in population centres.

Considerable attention has been paid to the vaccination and revaccination of the population. This measure has been carried out mainly in accordance with epidemiological indications and has been concentrated in regions where plague is enzootic.

Practice has shown that the cutaneous method of vaccination is the most suitable; despite the fact that intradermal vaccination, according to experimental data, gives the highest and most persistent immunity, its use on a large scale has proved impossible because of the major degree to which the vaccine provokes reaction when it is injected intradermally and the difficulty of organizing extensive vaccination of the people by this method.

Side by side with practical control and prevention work, the anti-plague stations also carry out extensive scientific research. This has been directed mainly towards solving problems connected with the suppression or eradication of natural plague foci. Scientific programmes in epidemiology, microbiology, zoology and parasitology are subordinated to this central problem.

The study of the general biological laws governing the focal nature of communicable diseases and the theory of Academician E. N. Pavlovski on this subject have also been reflected in the scientific research of the antiplague services, which have in their turn been of considerable assistance in further elucidating the laws of the development of plague in its natural foci and in devising eradication measures. Thus, the basic features of the Central Asian natural focus have been studied, particularly the mechanism by which an epizootic passes from season to season in the conditions prevailing in Turkmenia. The epizootological and epidemiological role of the great and red-tailed gerbils and some specific features of the influence of fleas on the epizootic process and on the possibility of human infection have also been established.

A great deal of research has been undertaken into the mechanism by which camels become infected with plague and into the formulation of measures to prevent such infection. As a result of the work carried out, together with experiments on the infection of camels with plague by various methods, the advisability of injecting camels with live plague vaccine has been established.

New forms and tactics of investigation in areas where plague is enzootic have been studied. The material obtained in this work has served as a basis for reviewing existing methods of investigation and has enabled the adoption of new methods of investigatory work in practice.

Problems connected with the treatment and urgent prophylaxis of plague have been studied in extensive experiments. As a result a rational schedule for the use of the most effective products has been drawn up and the advantage of using streptomycin and other antibiotics, rather than sulfanilamide therapy, has been proved; the way in which antibiotics act has been studied in detail.

An important preventive measure against plague has been worked out consisting of simultaneous action against the rodent reservoirs of the plague organism and the fleas which transmit it. It has been shown that this method can be used on a large scale, and it has been recommended for areas where fresh epizootics must be rendered completely safe in a short time. This method also opens up prospects of cleaning up natural foci more quickly and finally eradicating enzootic plague in them.

A number of methods of rodent control, particularly the poison-bait method, used against sisels and various species of gerbils, have been perfected.

The present epizootic conditions in the natural plague foci in the USSR and the sum of knowledge concerning these foci should make it possible to undertake in the very near future the task of sharply reducing the infectiousness of those foci which remain in Central Asia and Transcaucasia. The eradication of the foci in the western Caspian and Transbaikalian regions has already been achieved.

At the same time there is no justification for weakening the quarantine measures taken to prevent the importation of plague from neighbouring countries.

The wide experience of plague work accumulated in the USSR and in other countries makes it possible to adopt now a series of programmes on questions of organization and method in regard to the prophylaxis and control of plague, including methods of epizootiological investigation, the eradication of rodents and their ectoparasites, etc., for recommendation to countries which have natural plague foci on their territories.